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Sadeghi, Pedram ; Wu, Kaiyu; Rindzevicius, Tomas; Boisen, Anja; Schmid, Silvan

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Fabrication and characterization of Au dimer antennas on glass pillars with enhanced plasmonic response

Wednesday, 7th December - 13:30 - Poster Session - Tippie - Poster presentation - Abstract ID: 415

Mr. Pedram Sadeghi [1], ***Dr. Kaiyu Wu*** [2], ***Dr. Tomas Rindzevicius*** [2], ***Prof. Anja Boisen*** [2], ***Prof. Silvan Schmid*** [1]

1. TU Wien, 2. Technical University of Denmark

Introduction

Localized surface plasmon resonance (LSPR) in strongly coupled subwavelength metal nanoparticles has been studied extensively due to the potential applications in plasmonic sensing and surface-enhanced Raman spectroscopy (SERS). Recent studies have shown that "elevating" the nanoparticles results in even larger field enhancements, due to less screening of fields by the substrate. However, as the pillar height is increased, new plasmonic modes arise, which can change measured spectra significantly. Here, we present dark-field measurements of round Au dimer antennas on top of transparent SiO2 pillars. At certain pillar heights, a pronounced dip in the scattering spectrum is observed, which can be reproduced using finite-element method simulations.

Methods

Nanodisk dimer arrays are defined using electron-beam lithography with well-defined gaps from 15-30 nm. This is then followed by gold deposition and liftoff. Finally, nanopillars are defined using reactive-ion etching (RIE) with the nanoparticles functioning as an etch mask. A schematic of the fabrication process is given in figure 1a and an SEM image of a high-density array of 400 nm tall nanopillar dimers is shown in figure 1b.

Optical scattering spectra are measured with an optical dark-field microscope (Nikon Ti-U, NA = 0.9-1.0) in transmission mode. Light scattered by the sample is collected by a dark-field objective (Nikon, NA = 0.7, 60x) and sent to a high-sensitivity spectrometer (Andor, SR-303i) equipped with an EMCCD (Andor Newton) detector.

Results and Discussion

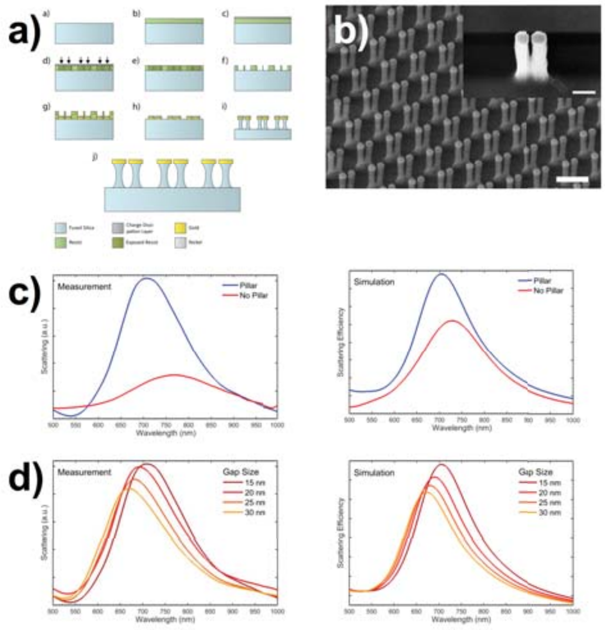
Figure 1c shows measured and simulated (FEM) scattering spectra of 150 nm dimer nanoantennas with 240 nm (blue) and 480 nm (red) pillars. The spectrum for the 240 nm pillars is dominated by a single peak at x nm, which is the expected coupled LSPR mode of the dimer. However, the 480 nm spectrum displays a pronounced dip at 680 nm. The simulations reproduce the data for the 240 nm qualitatively, while the 480 nm simulation only shows a single peak at x nm, as would be expected for the coupled mode.

The FEM simulations were performed with the incoming light perpendicular to the substrate surface. However, the actual measurements are done with a 64 degrees angle. Furthermore, the finite opening angle of the objective means that only some of the light is captured. By adjusting the simulations so that only light scattered from the top and bottom surface of the nanoparticle is detected, the spectra appear very similar to the measured ones.

From field distribution plots, it appear that a secondary mode forms at around x nm, which scatters the light in directions parallel to the substrate. Since only forward scattered light is captured in the experiments, a dip is formed in the spectra at the given wavelength.

Conclusion

The findings presented here shows problems that can be encountered when doing dark-field measurements in novel systems.



Figures.png